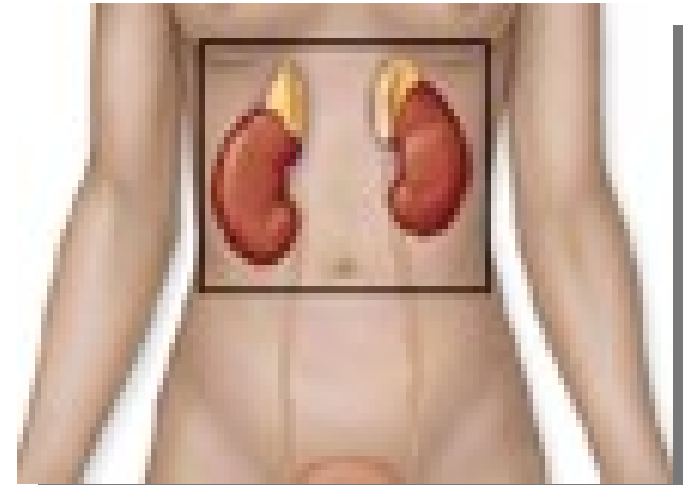
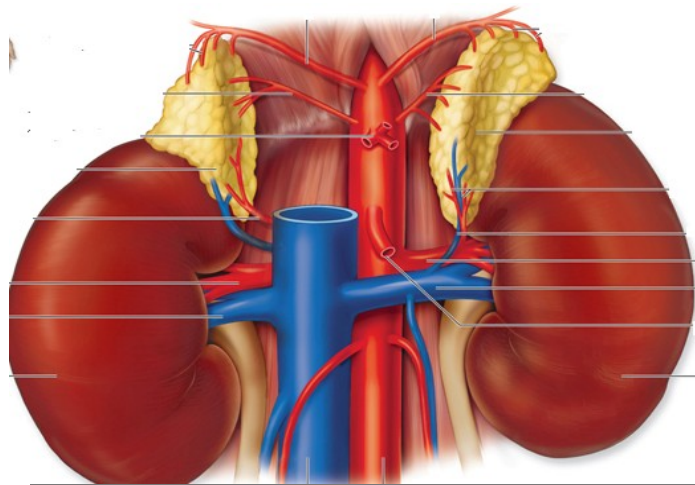




# **Armed Forces College of Medicine AFCM**



# Physiology of adrenal glands (1)

By

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(ASU)*

# INTENDED LEARNING OBJECTIVES (ILO)



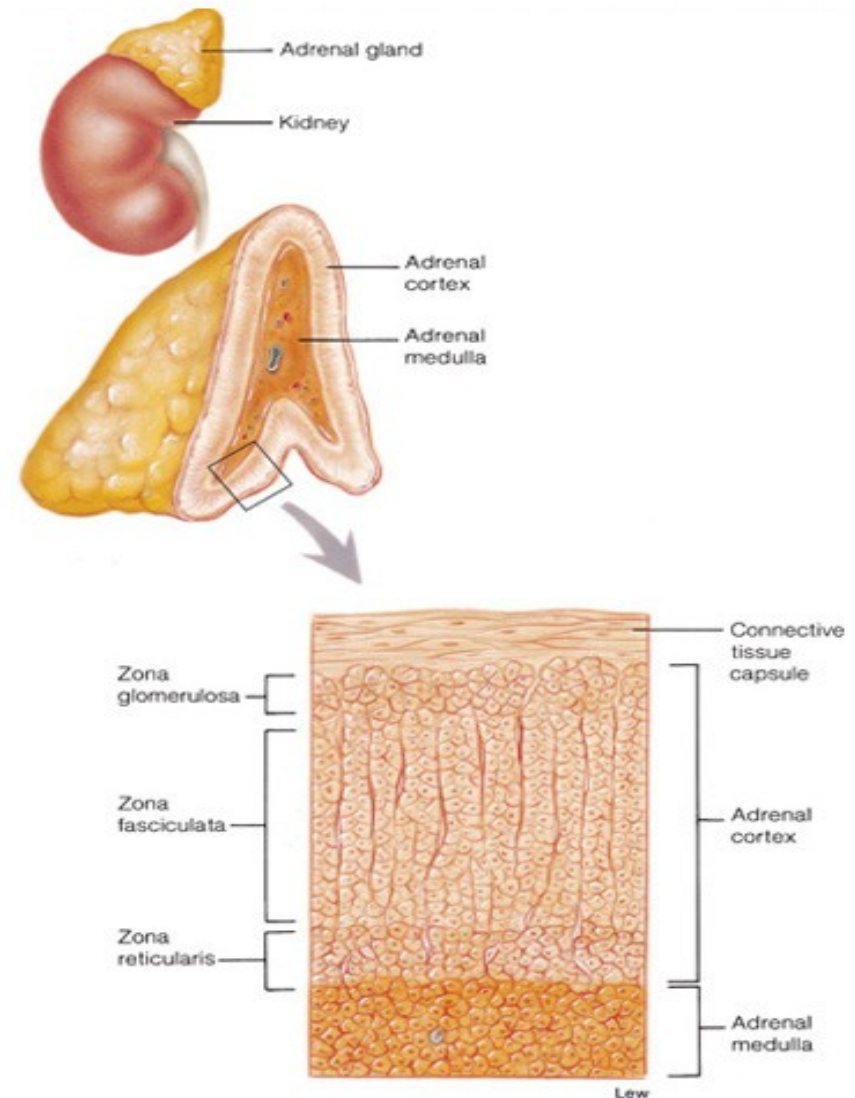
- By the end of this lecture (1), the student will be able to:

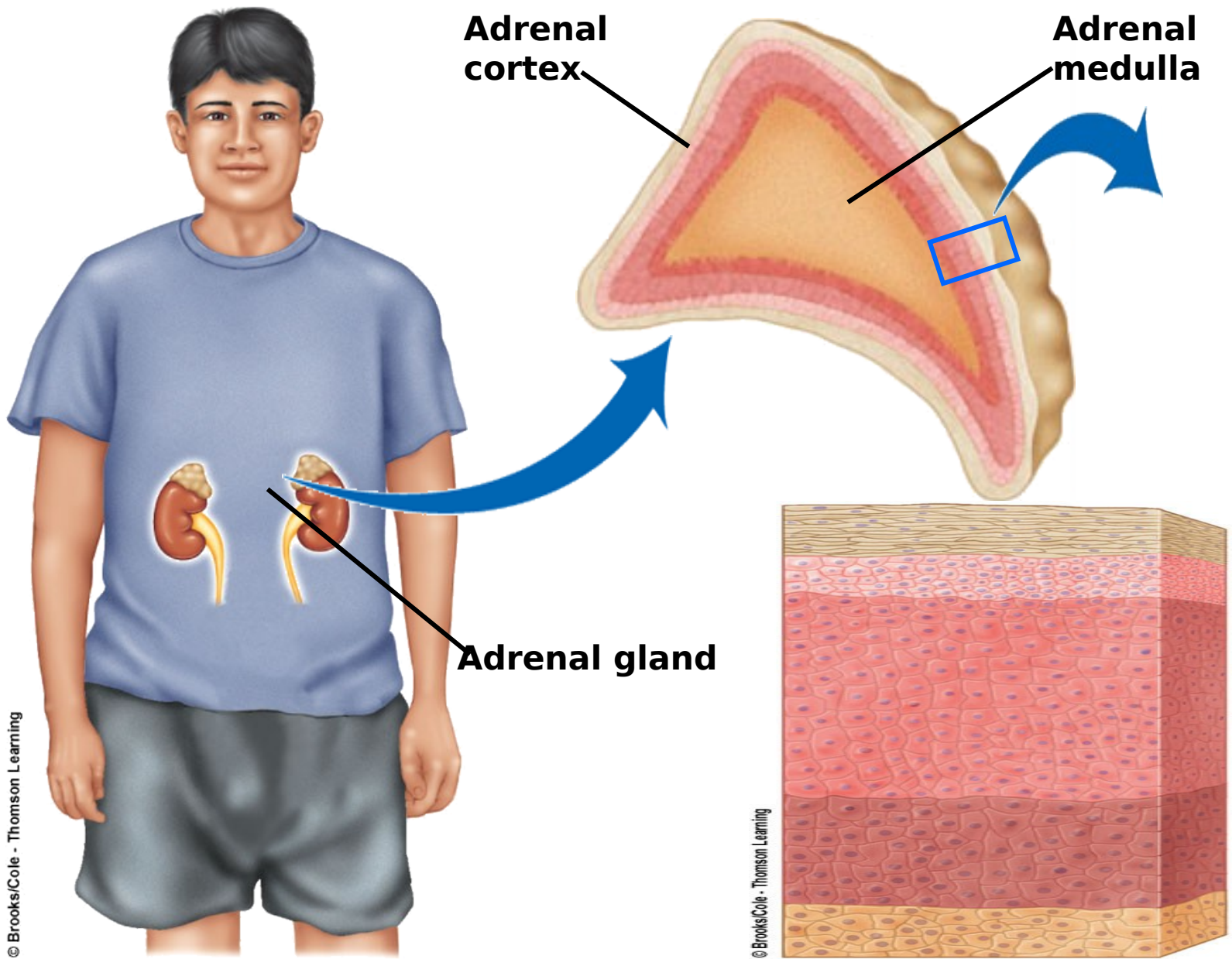
- 1- Name the layers of the adrenal gland and the major hormone products of each..
- 2- Understand the cellular mechanism of action of adreno-cortical hormones.
- 3- Identify the physiological actions of aldosterone hormone and its target organs.
- 4- List the factors that regulate secretion of aldosterone.
- 5- Explain consequences of over-secretion of mineralocorticoids.

# Adrenal Glands



- 2 Suprarenal glands, one on top of each kidney.
- Pyramid-shaped organs , each weighing 5 gm.
- Each consists of outer cortex and inner medulla that are structurally and functionally



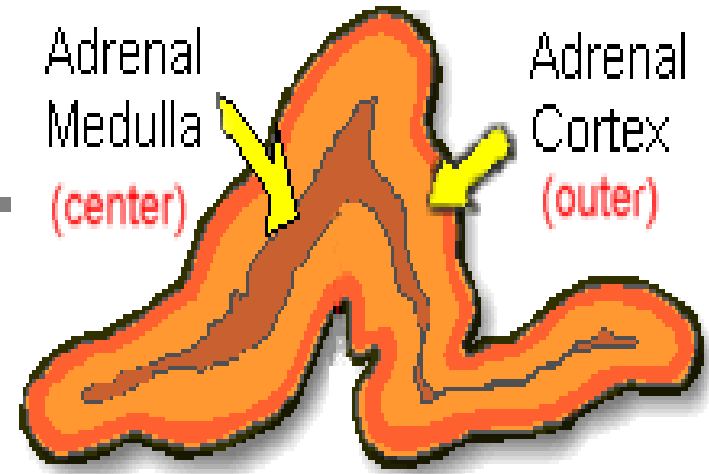


# Adrenal Glands



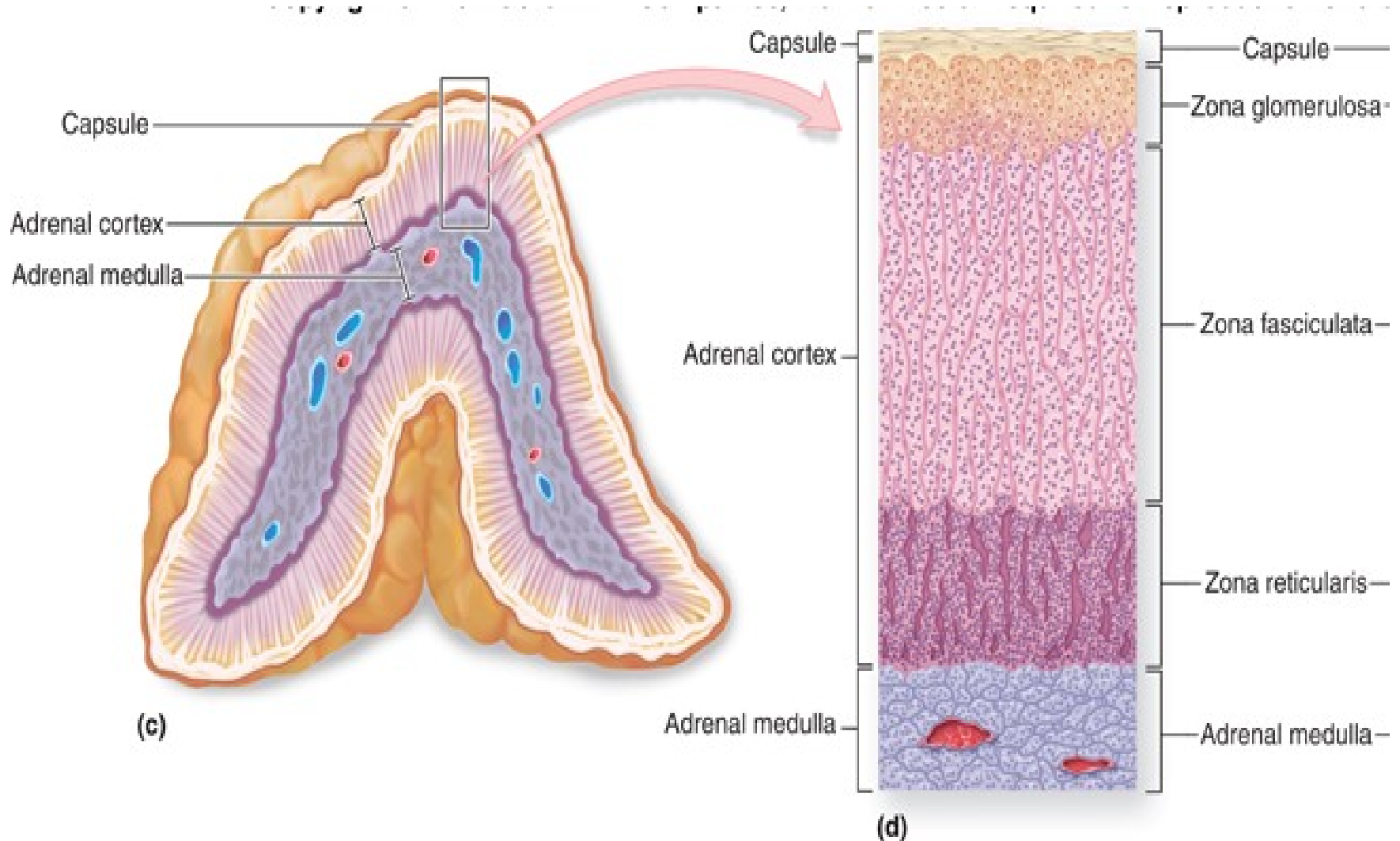
## ■ Structure:

- Adrenal Cortex (80%).
- Adrenal Medulla (20%).



- They are actually 2 endocrine glands.
- The cortex secretes different adrenocortical hormones which are essential for life while the medulla secretes catecholamines which are NOT essential for life.
- The cortex is under anterior pituitary control (ACTH), while the medulla is NOT under pituitary control (sympathetic division of ANS).

# Adrenal Glands

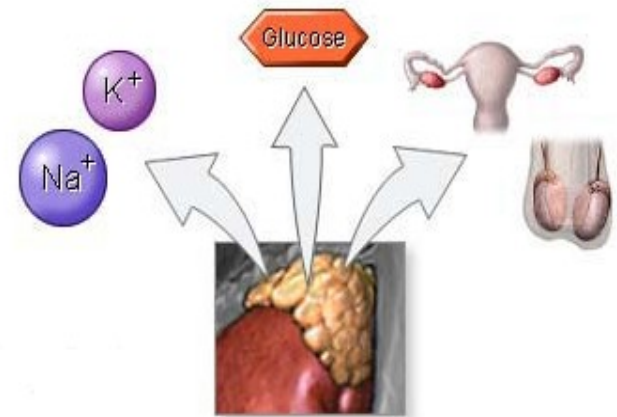




# Adrenal Cortex



- Outer part – 80% of gland



- Divided into 3 zones:

## 1- Zona glomerulosa.

- Mineralocorticoids (aldosterone & DOCA).
- Regulates level of sodium and potassium.

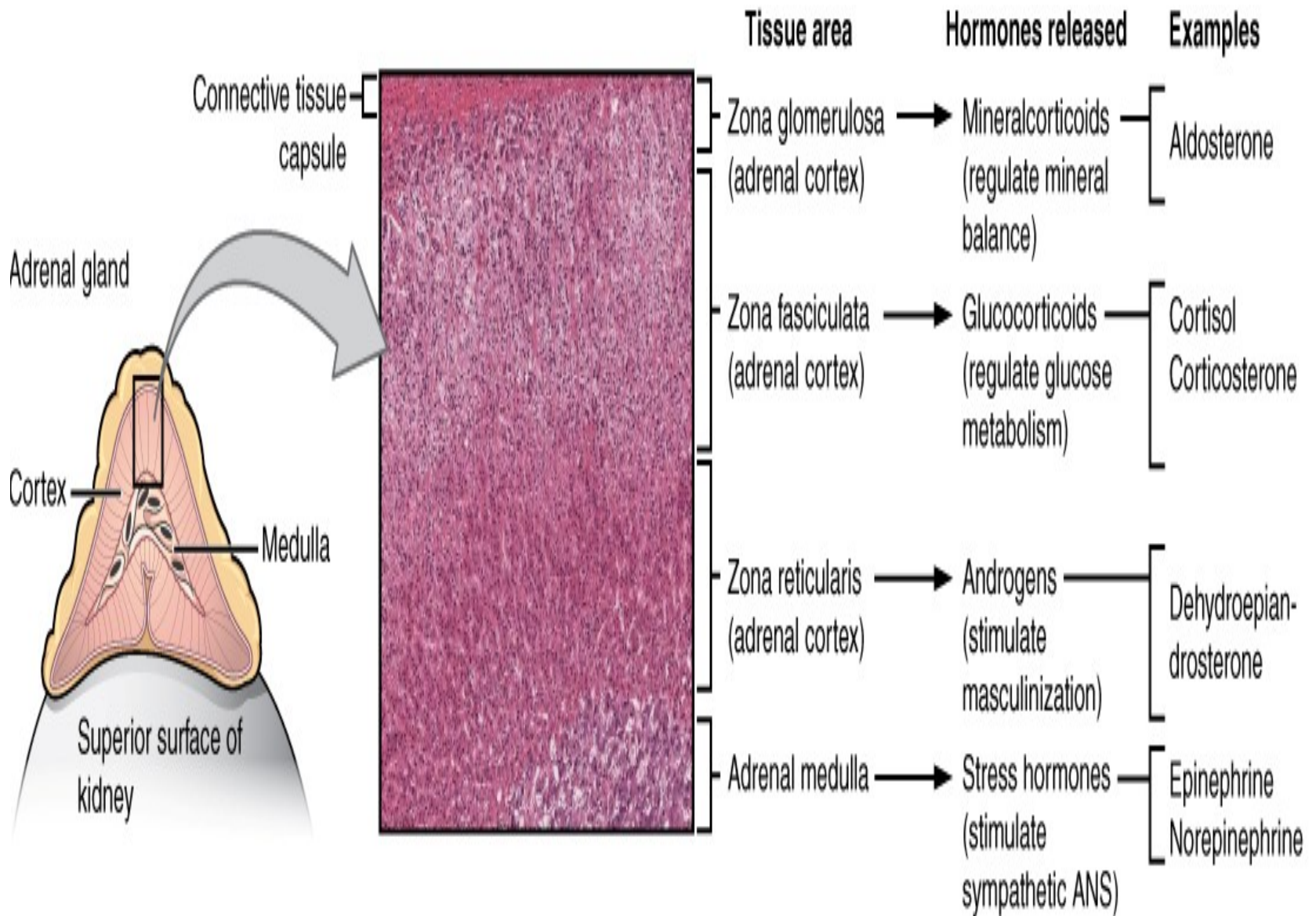
## 2- Zona fasciculata.

- Glucocorticoids (cortisol & corticosterone).
- Regulate metabolism of glucose, lipids & proteins.

## 3- Zona reticularis (sex hormones).

- Regulates **Salt**, **Sugar** and **Sex hormones**.





# Mineralocorticoids

## *(Aldosterone)*



- They are essential for life. **WHY?**

### 1- Site of release:

- They are secreted by the zona glomerulosa of adrenal cortex.
- **Aldosterone** is the most potent & main mineralocorticoid.
- **Deoxycorticosterone** is also secreted but has only 3% of the mineralocorticoid activity of aldosterone.

### 2- Nature:

- It is a steroid hormone.

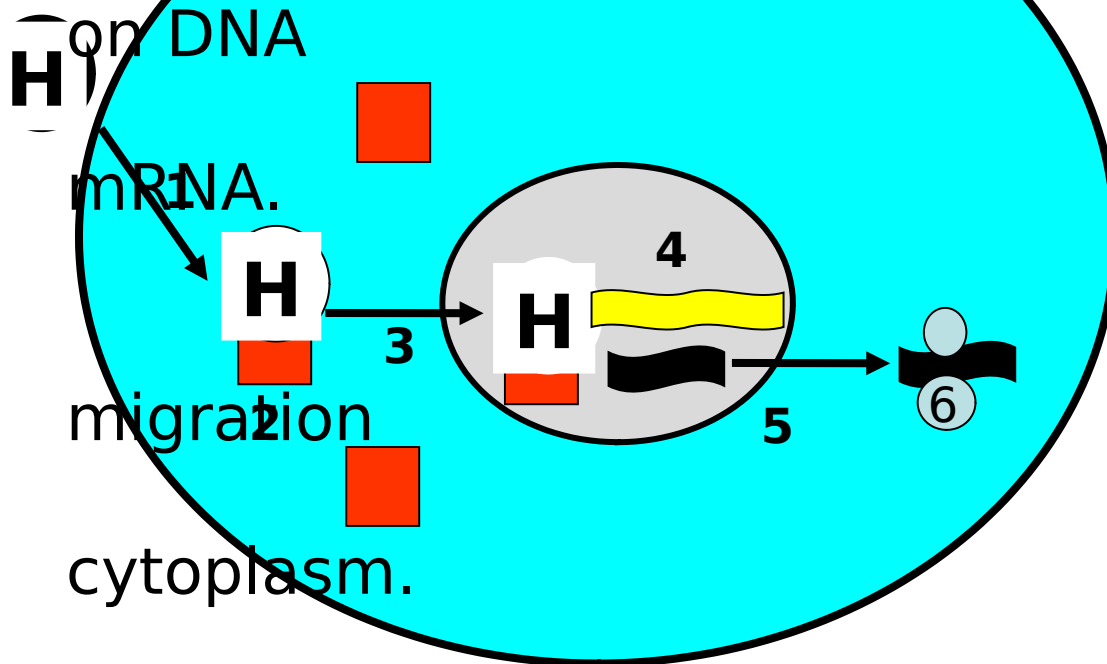
### 3- Normal level:

0.006  $\mu\text{g/dL}$

## 4- Mechanism of action:

1. Aldosterone is a lipophilic hormone → diffuses into the **renal tubular cells**.
2. Cytoplasmic receptor binding → forming aldosterone – receptor complex
3. Migration to the nucleus.

4. Bind to specific site (transcription) →

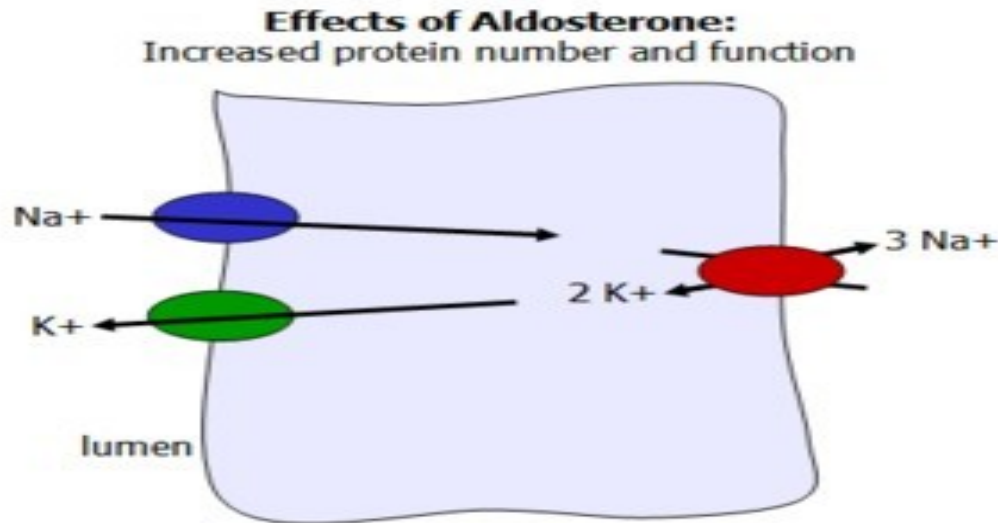


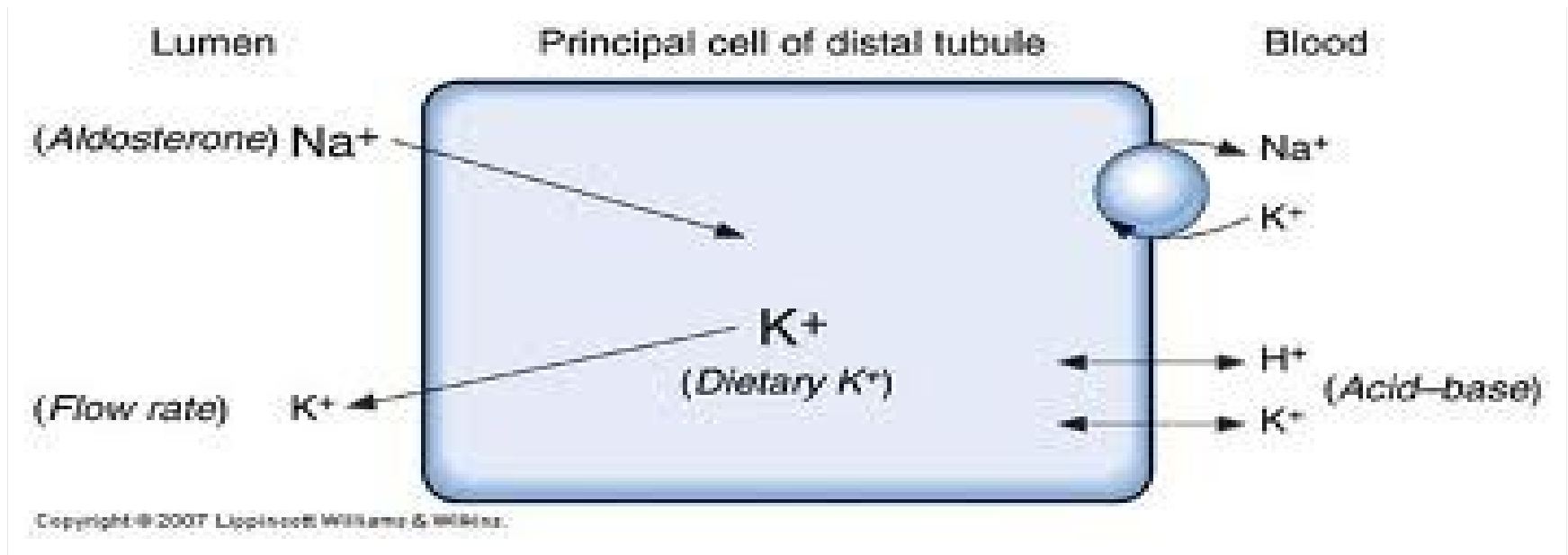
5. mRNA to

6. mRNA

## N.B.:

The new proteins are *epithelial sodium channels (ENaCs)* by increasing the insertion of these channels into the cell membrane (rapid effect); and a slower effect to increase the synthesis of ENaCs.





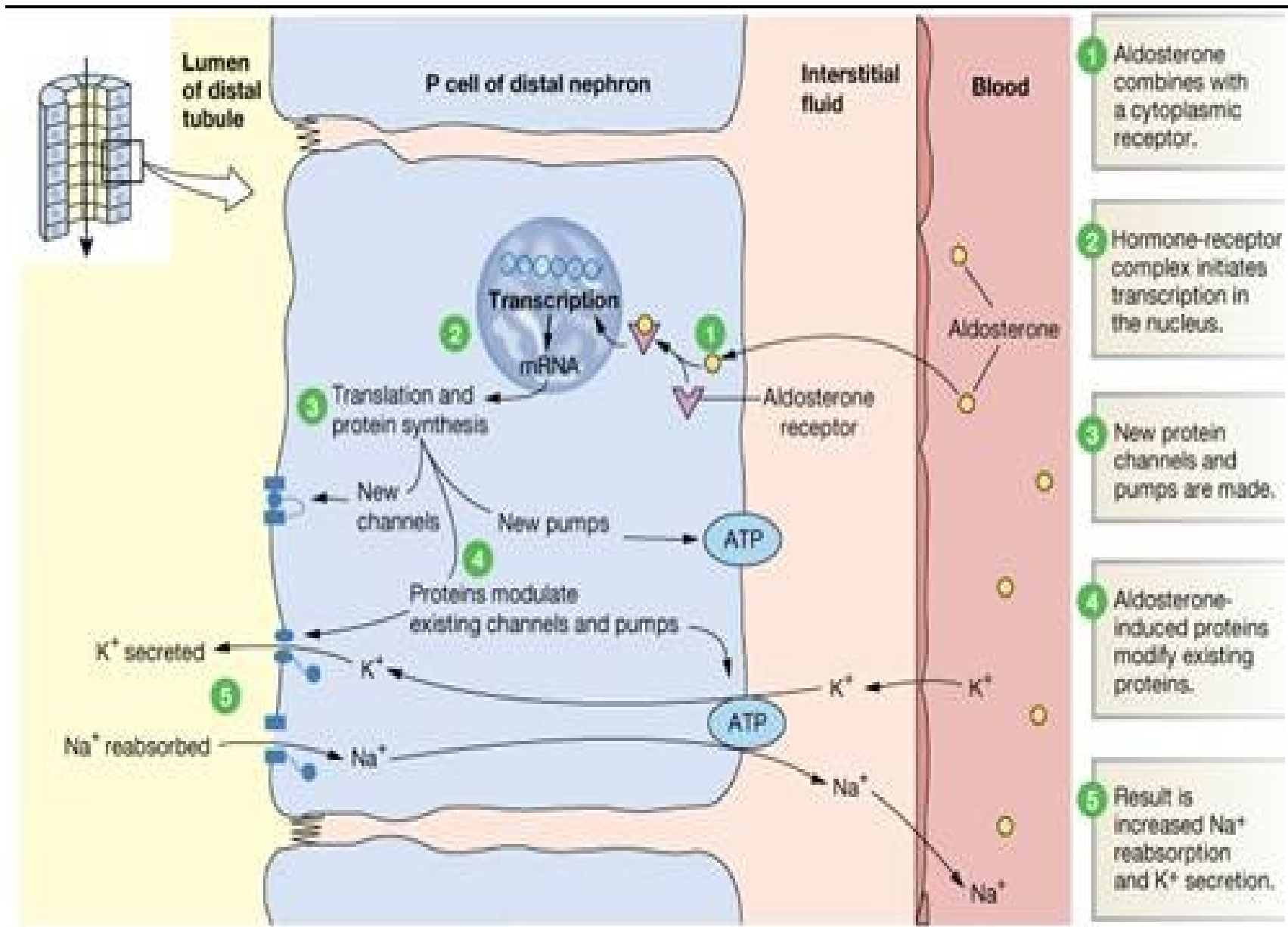
## 5- Actions:

- The **distal tubules of the kidney** are the primary target organs of aldosterone.

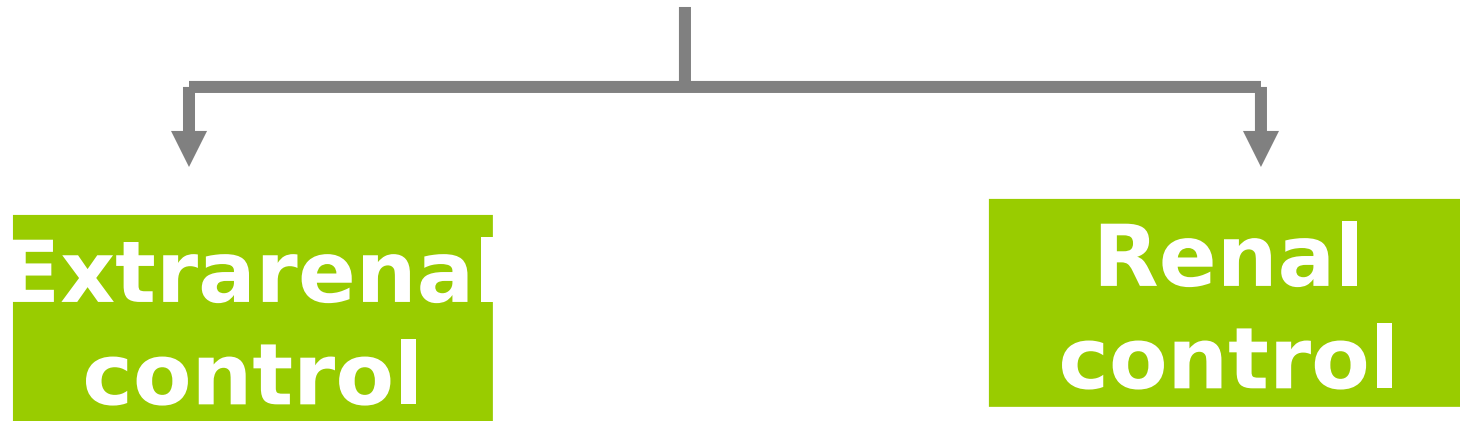
- ↑ ↑ reabsorption of  $\text{Na}^+$  with  $\text{Cl}^-$ ,  $\text{HCO}_3^-$  &  $\text{H}_2\text{O}$  following it.

- ↑ ↑ excretion of  $\text{K}^+$  and  $\text{H}^+$  (by ↑  $\text{Na-K ATPase}$  &  $\text{H}^+$  pumps).

- Also, aldosterone also ↑ ↑ sodium absorption from



# 7- Regulation:



## 1- Hyperkalemia. (Main) Renin-angiotensin system.

2- Hyponatremia.

3- HPA axis = ACTH (in stress).

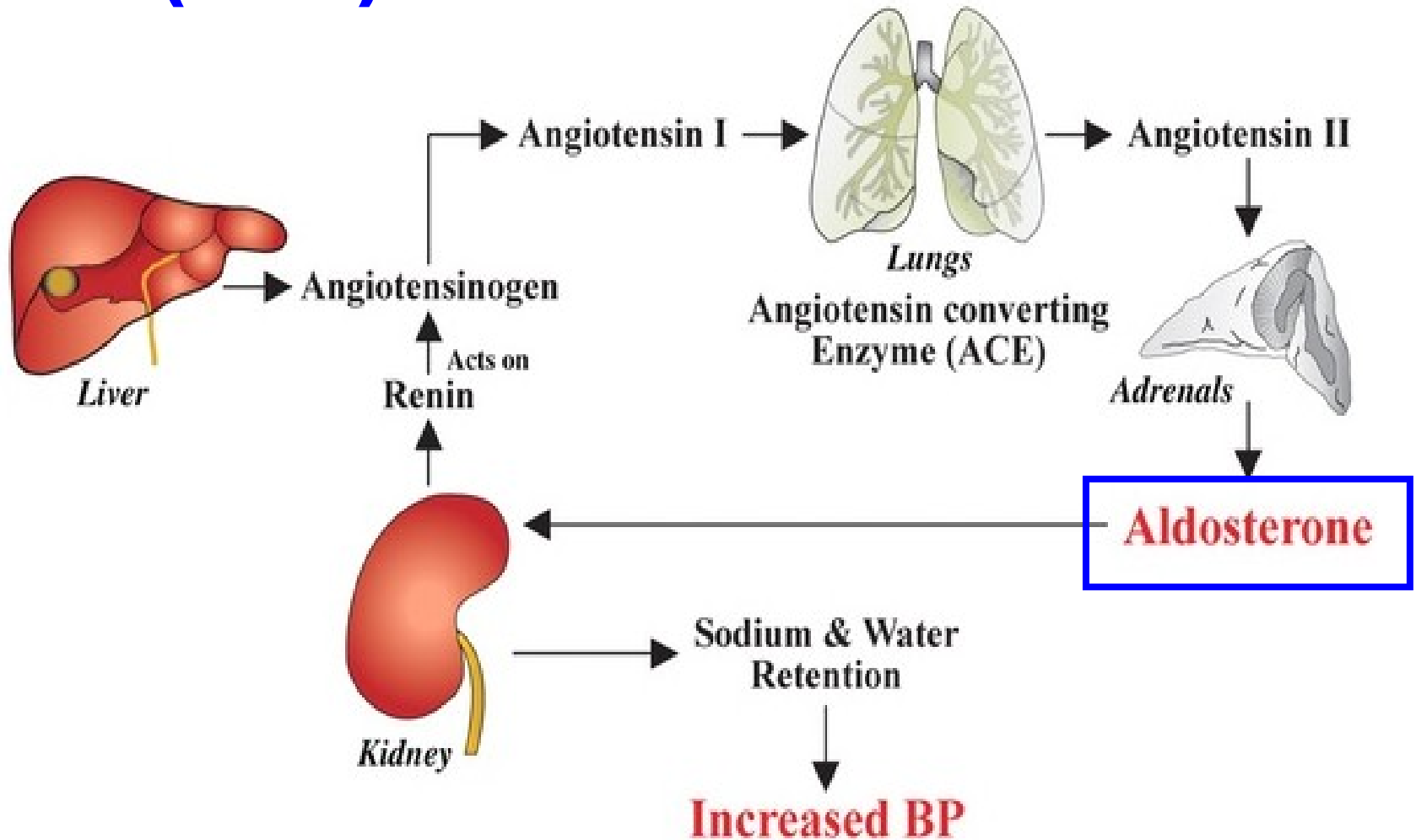
4- ANP  $\square$  (-) aldosterone secretion.

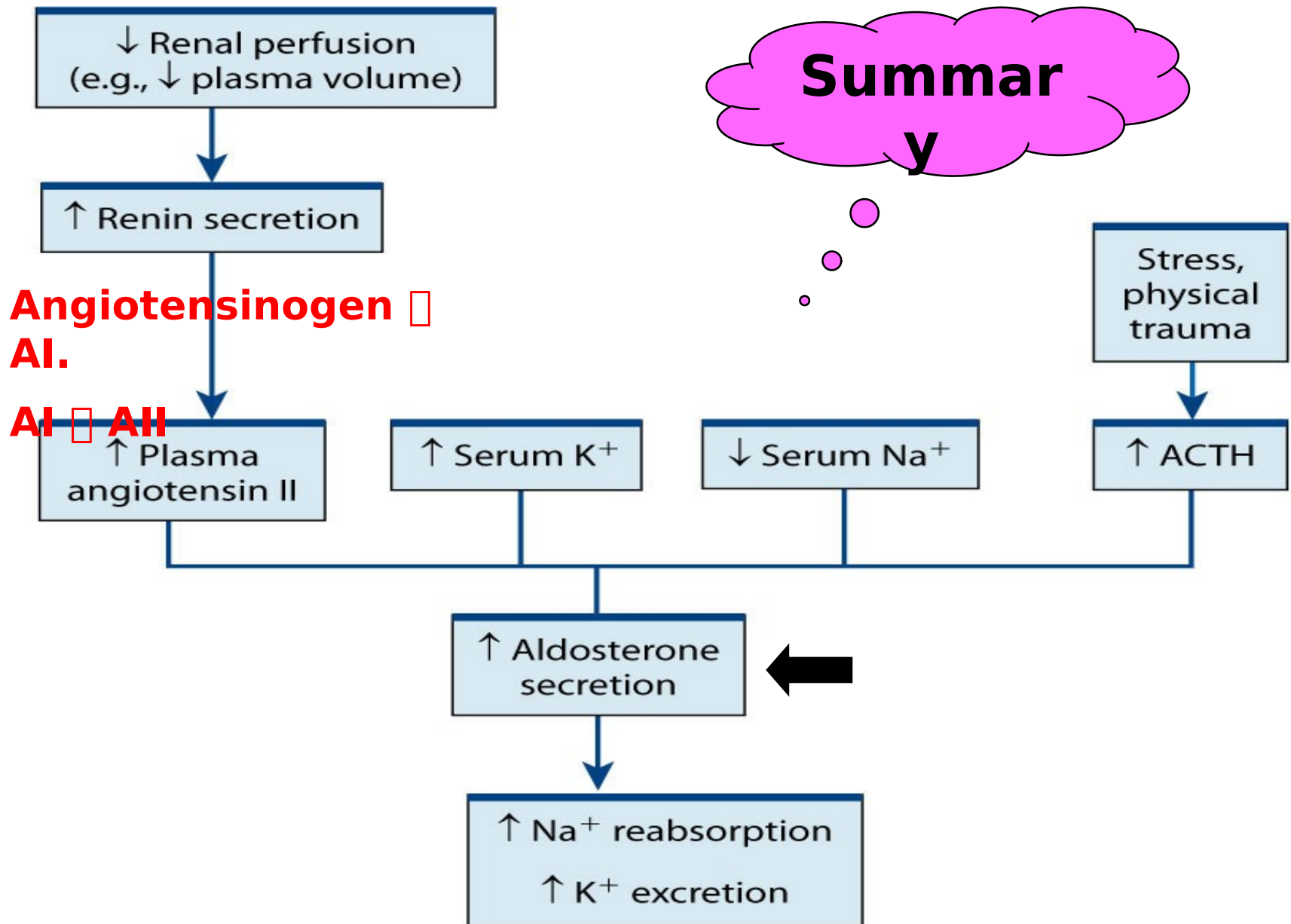
- Aldosterone is more

Renin is secreted by the JG cells in response to:  
e.g.  $\downarrow$  renal perfusion pr.



# Renin-angiotensin system (RAS)



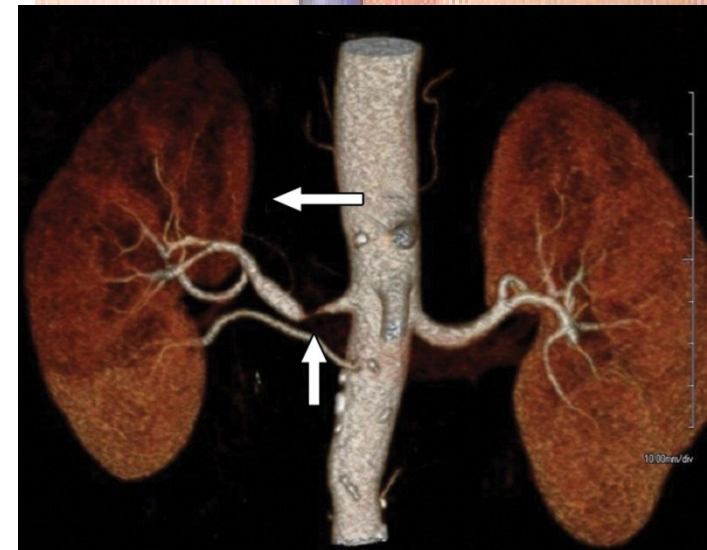
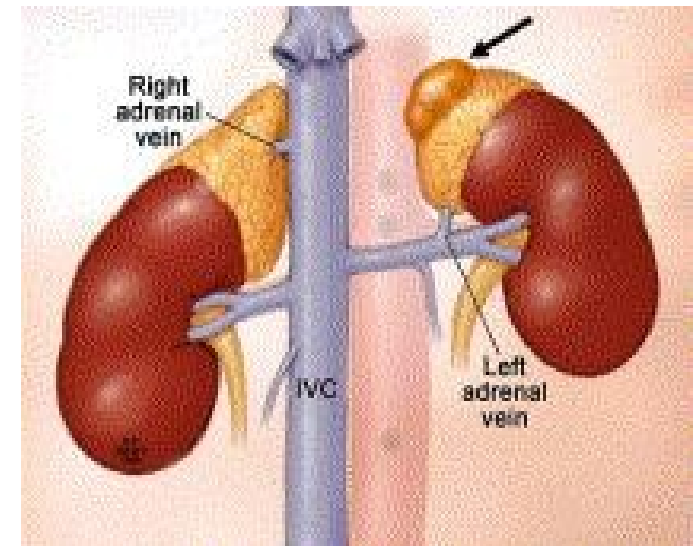


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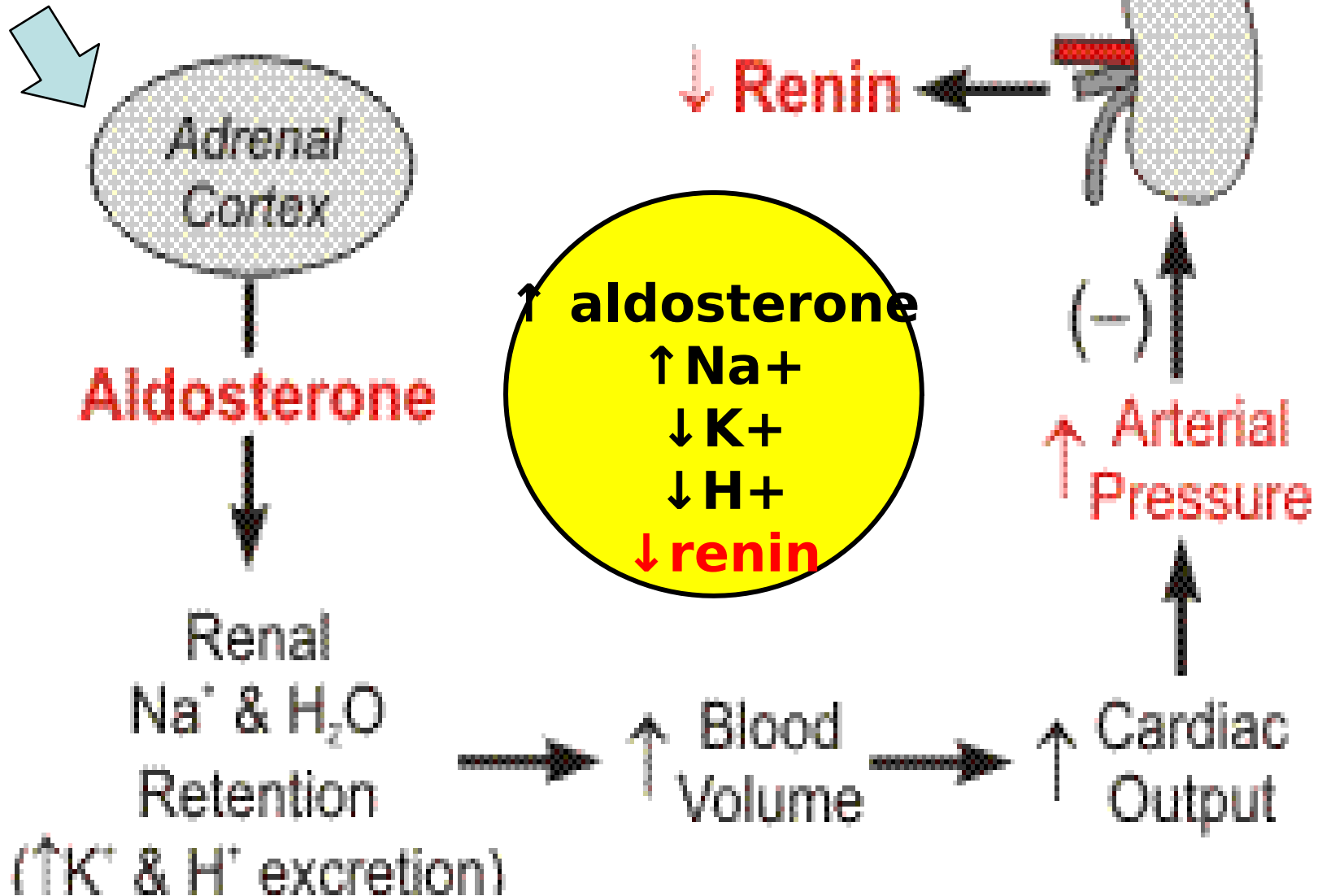
# Hyperaldosteronism



- **Primary hyperaldosteronism**  
(*Conn' disease*).
  - Adenoma in Z.G.
- **Secondary hyperaldosteronism**  
(High activity of RAS)
  - Renal artery stenosis.
  - Renin-secreting tumors (in JG cells).
  - Chronic odematous

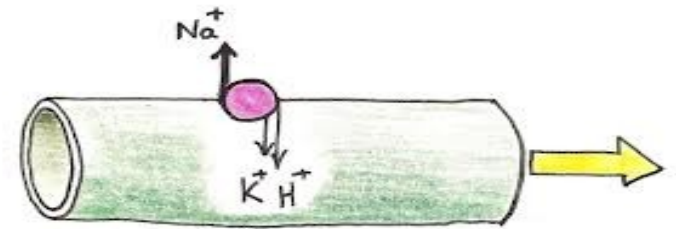


# Primary hyperaldosteronism



# Primary hyperaldosteronism (Conn's disease)

- **Cause:** adenoma in Z.G.
- Too much aldosterone secretion
  - **↑ Na<sup>+</sup>** (hypernatremia)
    - hypertension.
  - **↓ K<sup>+</sup>** (hypokalemia)
    - Muscle weakness.
    - Cardiac arrhythmias.
    - Glucose intolerance.
  - **↓ H<sup>+</sup>**
    - Metabolic alkalosis.
    - Tetany.



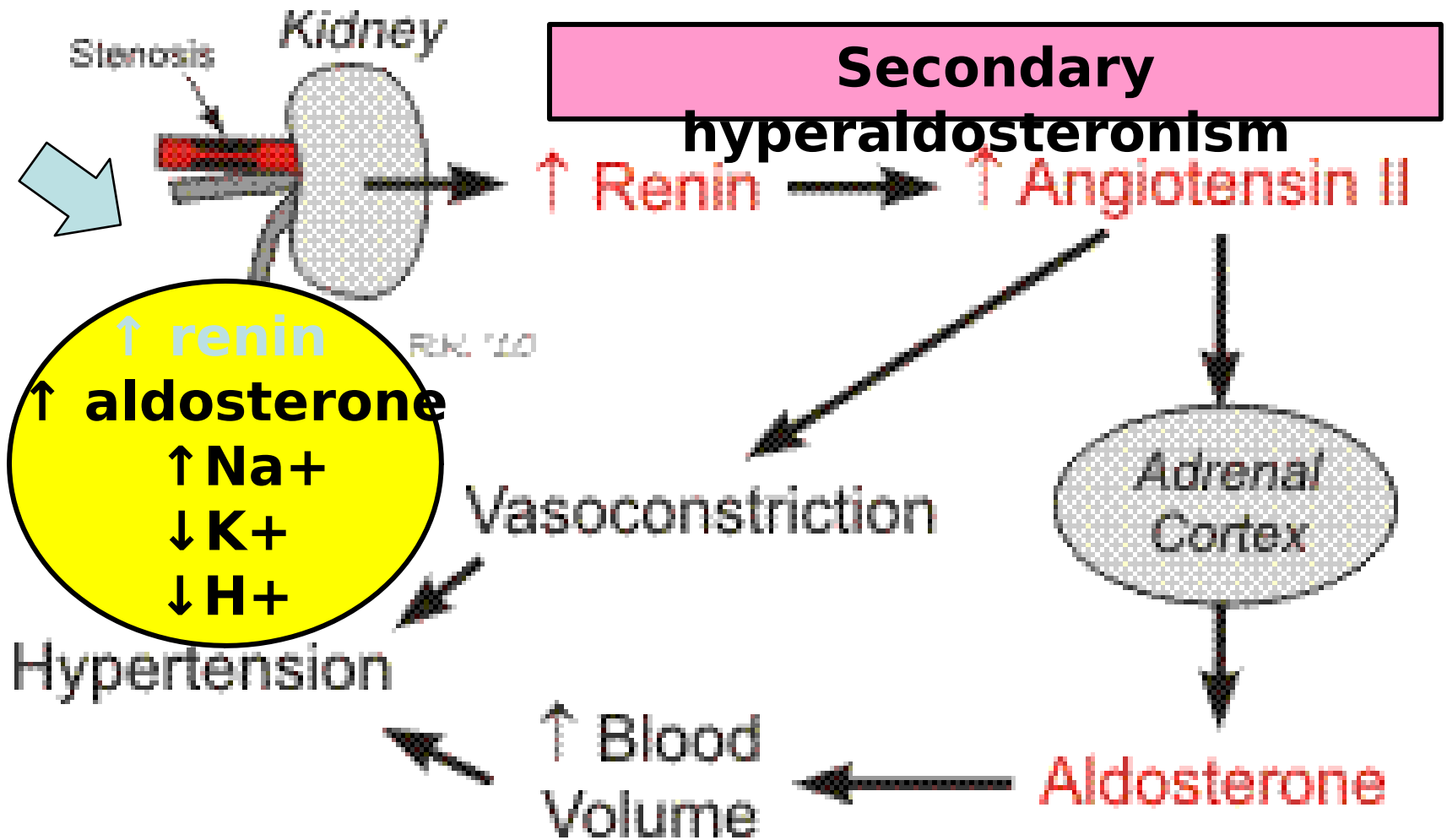
**Key**

**Primary hyperaldosteronism**  
Hypertension with  
hypokalemic  
metabolic alkalosis

**↑ Na<sup>+</sup>** or **↓ K<sup>+</sup>**  
**↓ H<sup>+</sup>**

**↑ Na<sup>+</sup> ↓ K<sup>+</sup> ↓ H<sup>+</sup>**

No edema Why???



<b>Conn's Syndrome (Primary Hyperaldosteronism)</b>	<b>Secondary Hyperaldosteronism</b>
<b>↓ plasma Renin</b>	<b>↑ plasma Renin</b>

# Lecture Quiz



## Q. Which of the following is true about the adrenal gland?

- a. The adrenal cortex secretes catecholamines.
- b. The adrenal medulla is under pituitary control.
- c. The adrenal medulla is essential for life.
- d. The adrenal cortex is under hormonal control.
- e. The adrenal cortex represents 25% of the adrenal gland.



# Lecture Quiz



Q. A 40 year - old woman is placed on high K diet for several weeks. Which of the following hormonal changes is most likely to occur:

- a) Increased secretion of cortisol.
- b) Increased secretion of DHEA.
- c) Increased secretion of aldosterone.
- d) Increased secretion of ACTH.
- e) Increased secretion of CRH.



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